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Management of Sheep On Range Infested With Orange Sneezeweed

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INTRODUCTION

In many places throughout the West the grazing of sheep on high-altitude summer ranges is complicated by the presence of orange sneezeweed [3] (fig. 1). This is particularly true in the central Rocky Mountains, where sneezeweed is common and is spreading rapidly. On many other summer ranges from Oregon and Montana south to California and New Mexico (fig. 2), sneezeweed infestations create a variety of problems depending upon local conditions and circumstances.

In Colorado alone, more than 1,500,000 acres of summer range land are infested, resulting in an estimated annual loss of $150,000 to wool growers of the State. Of the 600,000 ewes and lambs grazing these infested ranges, nearly 8,000 die each year from sneezeweed poisoning. In addition, lamb and wool crops are reduced (fig. 3). Moreover, the grazing capacity of the range is diminished to the extent that sneezeweed occupies land otherwise utilizable by desirable plants.

[1] This study was made possible through the cooperation of Theodore Parsons, Fred Donley, and Joseph Savornin who owned the livestock and furnished essential records on marketing and weight of lambs. Valuable assistance was contributed by James B. Beals, supervisor of the Uncompahgre National Forest, and Forest Rangers Nathaniel Walker and Bruce Torgny. Special acknowledgement is due Work Projects Administration Project No. 5063 for aid in the compilation of data.

[2] Maintained by Forest Service, U. S. Department of Agriculture, in cooperation with Colorado State College of Agriculture and Mechanic Arts, Fort Collins, Colo.

[3] Orange sneezeweed is the accepted common name of *Helenium hoopesi*, but sneezeweed will be used hereafter for brevity.

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If these losses are not to continue, systems of grazing must be practiced which will prevent or greatly reduce the feeding upon sneezeweed. Several methods of managing sheep on sneezeweed-infested range have been suggested, based chiefly on wool growers' reports and other general observations. In Utah, for example, as noted by Dayton et al. (*10*),[4] losses have been greatly reduced by the temporary expedient of moving the sheep, showing symptoms of poisoning, to lower uninfested brush ranges until their condition is improved. Marsh et al. (*9*) have suggested that in some cases a change of use from sheep to cattle might be feasible, since sneezeweed is so unpalatable to cattle that they seldom eat the plant and only rarely are poisoned under range conditions. As far as is known, there have been no other extensive investigations conducted on sneezeweed. Marsh (*8*), Durrell and Glover (*4*), Durrell and Newsom (*5*), and the Range Plant Handbook (*10*) consider the sneezeweed problem. An unpublished record of a series of eradication experiments conducted by the Forest Service on the White River National Forest in Colorado indicates that grubbing was partially effective but very expensive. Other informal reports show that sneezeweed areas protected from grazing for 14 years on the Holy Cross National Forest in Colorado have changed but little in composition, but that mountain meadows taken over by heavy sneezeweed stands have recovered remarkably when irrigated and reseeded with Kentucky bluegrass (*Poa pratensis*) or smooth brome (*Bromus inermis*).

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FIGURE 1.—Sneezeweed at maturity—flowering stems grow from 18 to 36 inches high and produce sunflowerlike heads. Except during the flowering period most specimens of the plant occur as clumps of rosettes composed of glossy green leaves from 4 to 10 inches long. The entire plant is poisonous to sheep in all seasons.

Prior to the present studies no experimental work was conducted on actual management practices designed to reduce death losses from sneezeweed poisoning. Although good results have been obtained on some areas by desirable livestock management, in many other instances severe losses from sneezeweed poisoning are still occurring or threatening. In order to establish a sound basis for improved prac-

[4] Italic numbers in parentheses refer to Literature Cited, p. 28.

tices for use on infested range, a study of the effects of management on poisoning losses was undertaken in Colorado in 1938 (*2*, *11*).

In the course of a careful preliminary survey of the problem throughout the State, a range was found where two bands of sheep were grazing adjacent allotments under somewhat different management and with different losses from poisoning. This range presented many favorable aspects for study, and detailed observations

FIGURE 2.—Major distribution of orange sneezeweed in the United States.

were made here during the summer grazing seasons of 1939, 1940, and 1941.

A careful study was made of the types of management of the sheep on each area as it varied from year to year. Results of the various practices followed made possible recommendations for desirable practice here presented. Few of these recommendations will be new to users of infested range, but the results of their application expressed

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FIGURE 3.—Sneezeweed poisoning may result in reduced wool production, low lamb crops, and loss of weight or death of individual lambs. This ewe is typical of chronic cases in the final stages before death. Lambs accompanying poisoned ewes are often undernourished.

in terms of lessening of death losses on the summer range should give them new significance to wool growers and range administrators alike.

CHARACTERISTICS OF SNEEZEWEED

Sneezeweed is commonly known as western sneezeweed, owlsclaw, or yellowweed. It is a stout perennial herb of the composite family. Most mature plants consist of one to several flowering stems and a number of rosettes, all closely massed in a clump 4 to 12 inches in diameter. The flowering stems are about 2 feet in height; stems are leafy and bear from 1 to 10 sunflowerlike heads which are 2 or 3 inches broad with brownish centers and orange-yellow petals. Leaves are from 4 to 10 inches long and are deep glossy green. The plant has a short, woody, usually crooked taproot.

In Colorado heavy stands of sneezeweed are known to occur at all elevations from 7,000 to 12,500 feet and in nearly every forage type within that belt. Maximum growth is made on good, loamy, well-drained soils of level or gently sloping areas in parks or dry meadows in golden aspen (*Populus tremuloides aurea*) and in silver sagebrush (*Artemisia cana*) types, or in openings in the Engelmann spruce-corkbark fir (*Picea engelmanni-Abies arizonica*) types.

Sneezeweed is aggressive and persistent. Because it reproduces prolifically by seed and by offshoots developed from adventitious buds

on the taproots, the plant is able to invade and to compete successfully with most other associated vegetation, particularly where the soil has been disturbed by heavy grazing, trampling, or accelerated erosion. Seedlings may be produced throughout the growing season and are especially abundant in the late summer and fall. Offshoots are produced principally in the fall from the taproots or root collars of mature plants flowering during the current season (fig. 4). These offshoots continue growth in the fall after frost, when other associated vegetation is dying or dead. In this manner sneezeweed remains green and succulent long after other forage plants are dry. Many

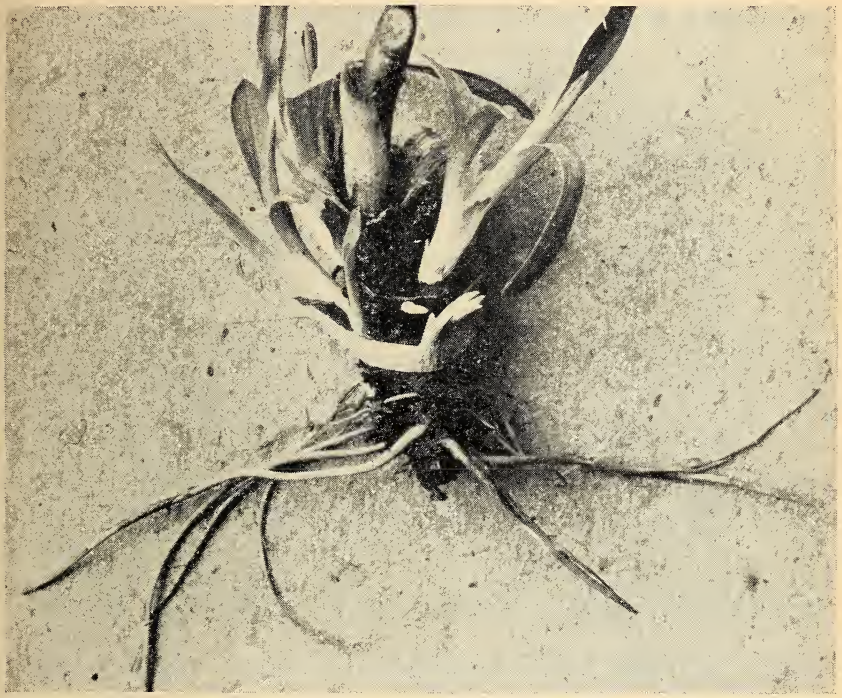

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FIGURE 4.—Numerous buds and offshoots are produced on the taproots or root crown in the fall (September).

sneezeweed plants remain green under the snow throughout the winter (fig. 5). As the snow disappears in the spring, active growth begins, and within 2 weeks the plants are 4 to 6 inches high and well in advance of nearly all associated species (*1*). Because they are green earlier in the spring and later in the fall than associated species, they are conspicuous to sheep and, therefore, are likely to be grazed extensively at these times, with serious results.

The extensive investigations of the chemical composition, toxicity of sneezeweed, and pathology of the poisoning made by Marsh et al. (*9*) in Utah from 1915 to 1920 were the first to prove that this plant produces "spewing sickness," a disease known on sheep ranges of Utah since 1903.

Marsh et al. found the poisonous material in sneezeweed to be an easily decomposed glucoside called dugaldin. All aerial parts of the plant, i. e., stems, leaves, and flowers, are equally poisonous, and are toxic throughout the growing season. Feeding tests with fresh plants indicated that the average toxic dose for a 100-pound sheep was 2.17 pounds of sneezeweed fed daily for a period of 21.6 days. Variations in the quantity and time necessary to produce symptoms were also apparent. Acute cases could be produced by 1 day's feeding of 2.5 pounds per hundredweight of animal. However, a daily feeding of

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FIGURE 5.—Plants often remain green under the snow during the winter, and develop in advance of associated vegetation in the spring. Twelve inches of snow which had been on the ground the entire winter was removed from these sneezeweed plants just before the photograph was taken.

less than 1.5 pounds could be consumed without toxic effects. These workers demonstrated that the poison, if taken in sufficient quantities, is cumulative from day to day and season to season, and produces permanent effects from which recovery is rare. No medicinal remedy was found to be effective.

The prominent symptoms of the poisoning are general depression, weak and irregular pulse, stiffness, extreme weakness, restlessness, nausea, coughing, and chronic vomiting. Vomiting is, however, not characteristic of acute cases. Death comes quietly without convulsions.

Several natural enemies of sneezeweed have been discovered, but it is not anticipated that any will ever be sufficient to control the

growth or spread of sneezeweed to any appreciable extent. A rust (*Puccinia conspicua*) infests the leaves of the plant,[5] but it is quite rare and its limited occurrence results in little damage. Larvae[6] were found in the taproots of some plants, devouring large portions of the root; but these are found primarily in the older, decadent roots. Other kinds of larvae infest the flower heads, and may reduce seed germination as much as 50 percent; but the seed is produced in such great abundance that even this reduction is of little consequence.

All data available from these varied investigations point to management of grazing animals as the only reliable means of reducing sneezeweed-poisoning losses.

DETAILS OF THE STUDY

This study was designed for actual observation of sheep grazing on sneezeweed-infested ranges, to the end that the effects of management or handling practices on these lands could be measured and evaluated. Both the bands of sheep selected for study had suffered losses from sneezeweed poisoning in past years. Each was composed of approximately 1,000 ewes with lambs, and all were typical cross-bred range stock of about equal quality.

Ranges Studied

The ranges involved in this investigation are on the Uncompahgre Plateau in western Colorado. Occupying approximately 13,000 acres, at elevations ranging from 8,500 to 9,600 feet, the grazing allotments were generally rough and contained many small mesas and V-shaped canyons. Large areas supported mixed stands of Engelmann spruce and corkbark fir, which were either unsuited to grazing or had a very low grazing capacity. Most usable range was in the golden aspen type, which has an understory of bunchgrass, weeds, and browse (fig. 6, *A*). Open parks dominated principally by hairy golden-aster (*Chrysopsis villosa*) intermingled with the conifer stands, and mountain meadows contributed in limited extent to the grazing capacity (fig. 6, *B*).

Yearly precipitation in the general area is about 25 inches, the major part of which occurs as snow. The grazing season begins in late June and lasts until early September.

The two adjacent allotments were rather similar for mountain ranges. Major vegetation types (fig. 7), climate, topography, and elevation were all essentially the same. Allotment 1, grazed by the sheep designated as band 1, was considerably smaller than allotment 2, having about half as many surface acres (table 1). A larger portion of allotment 2, however, was covered with dense stands of conifers and could not be used by sheep; and the fact that part of this allotment was grazed by cattle tended to reduce the forage available for sheep.

[5] The alternate host of the rust is prairie junegrass (*Koeleria cristata*).

[6] The larvae were reared to adults by R. L. Furniss of the Bureau of Entomology and Plant Quarantine. L. G. Baumhofer of the same Bureau identified the specimens as a moth (*Hysterosia fuviplicana* Wlsm.) of the family Phaloniidae.

The available forage (forage acres)[7] on the allotments was estimated during each year of the study by intensive surveys of each range subtype used by the sheep. This forage inventory was made

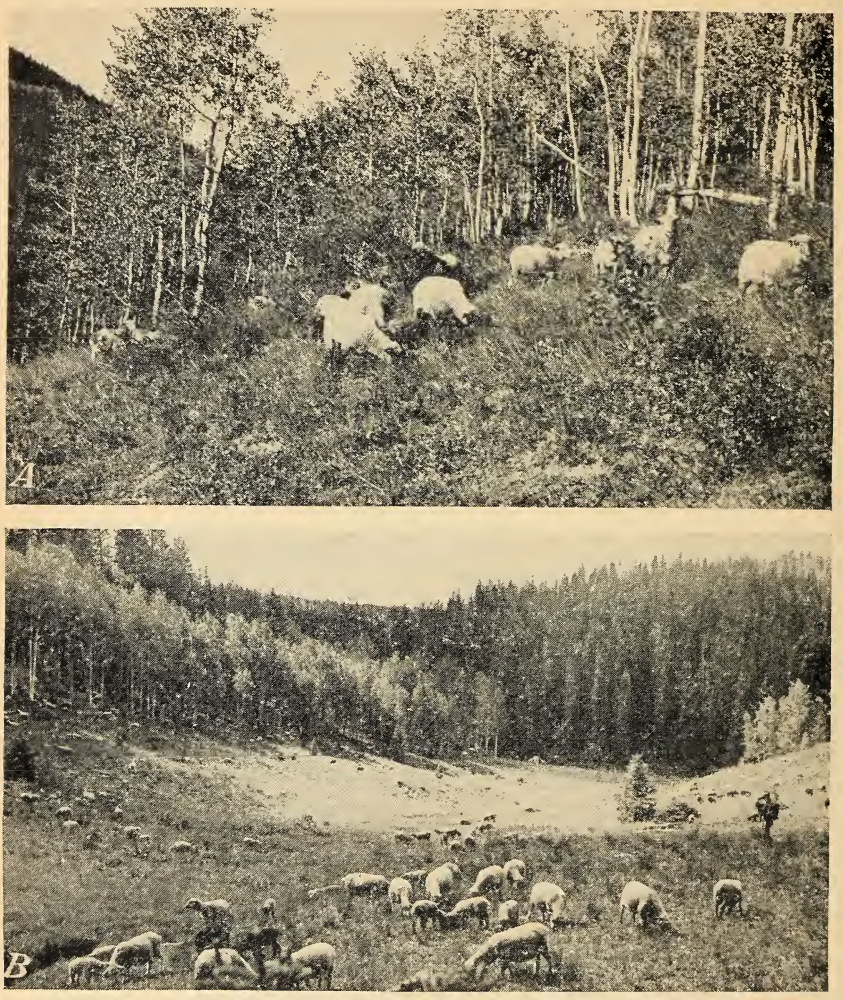

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FIGURE 6.—Typical vegetation on study area. *A*, Golden aspen type was the most important forage-producing area. Predominant forage plants were sedges (*Carex* spp.), aspen peavine (*Lathyrus leucanthus*), mountain thermopsis (*Thermopsis montana*), western yarrow (*Achillea lanulosa*), Thurber fescue (*Festuca thurberi*), and mountain snowberry (*Symphoricarpos oreophilus*); *B*, parks of low grazing capacity and mountain meadows provided a portion of the summer forage for the sheep.

in accordance with the square-foot density method described by the Inter-Agency Range Survey Committee (*6*), and indicates the relative forage available on the two allotments (table 1).

[7] Forage acres=average density × proper-use factor × surface acres. A local proper-use factor table was developed from actual utilization data and used in the computations.

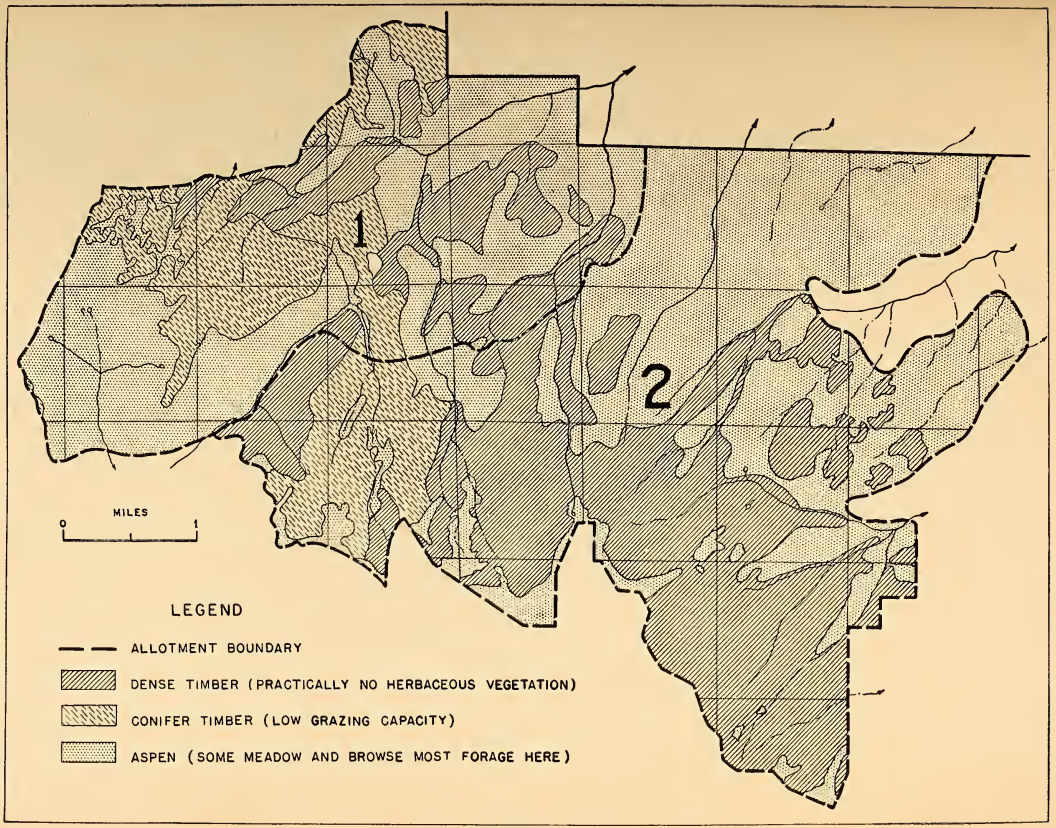

FIGURE 7.—Comparison of vegetation types on allotments 1 and 2.

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TABLE 1.—*Comparative size, available forage, and actual use of study allotments*

Allotment and year	Total area	Area available to sheep	Forage acres	Actual use
Allotment 1:	*Acres*	*Acres*	*Acres*	*Sheep-months*
1939	4,888	2,514	70.02	2,270
1940	5,222	3,783	116.58	2,695
1941	4,768	3,068	108.16	2,167
Average	4,959	3,122	98.25	2,377
Allotment 2:				
1939	8,952	4,429	158.88	3,220
1940	8,952	5,044	158.35	2,336
1941	8,952	4,520	168.28	1,800
Average	8,952	4,664	161.84	2,452

TABLE 2.—*Composition of the vegetation, in percentage of the total available forage each year contributed by the major species* [1]

Species	Allotment 1			Allotment 2			3-year average	
	1939	1940	1941	1939	1940	1941	Allotment 1	Allotment 2
Grasses and grasslike plants:								
Wheatgrasses (*Agropyron pauciflorum* and *A. subsecundum*)	0.84	0.87	0.86	0.55	1.37	1.00	0.86	0.98
Brome (*Bromus carinatus* and *B. ciliatus*)	.38	.56	.84	1.60	1.11	.77	.62	1.15
Fescue (*Festuca thurberi, F. ovina,* and *F. idahoensis*)	7.99	4.55	4.04	1.59	1.37	1.25	5.19	1.40
Needlegrasses (*Stipa lettermani* and *S. columbiana*)	4.73	1.74	.96	.82	3.97	1.70	2.17	2.15
Other grasses	.59	1.42	.82	.47	1.39	1.76	1.03	1.21
Sedges (*Carex* spp.)	13.29	10.16	6.95	9.01	12.97	5.70	9.76	9.16
Total	27.82	19.30	14.47	14.04	22.18	12.18	19.63	16.05
Weeds:								
Western yarrow (*Achillea lanulosa*)	2.08	3.24	3.59	1.73	3.41	3.32	3.10	2.83
Hairy golden-aster (*Chrysopsis villosa*)	3.03	6.22	11.93	1.64	2.27	1.75	7.48	1.88
Aspen fleabane (*Erigeron macranthus*)	1.15	1.12	1.25	2.79	2.76	2.21	1.18	2.58
Showy frasera or elkweed (*Frasera speciosa*)	3.60	1.92	1.77	2.54	1.03	2.12	2.27	1.90
Sneezewood (*Helenium hoopesi*)	4.46	7.48	2.91	.81	1.37	2.04	4.93	1.42
Aspen peavine (*Lathyrus leucanthus*)	5.62	7.49	8.02	4.49	8.57	10.44	7.25	7.88
Pseudocymopterus or false-carrot (*Pseudocymopterus montanus*)	4.76	5.32	6.78	5.54	2.31	4.04	5.74	3.96
Groundsel (*Senecio* spp.)	.85	1.15	1.32	4.32	1.26	3.58	1.15	3.07
Fendler meadowrue (*Thalictrum fendleri*)	2.35	3.54	3.69	1.47	6.69	6.05	3.32	4.76
Mountain thermopsis (*Thermopsis montana*)	4.50	3.71	2.83	6.83	8.61	9.90	3.59	8.47
Other weeds	12.62	22.12	25.63	8.56	8.78	11.87	21.19	9.79
Total	45.02	63.31	69.72	40.72	47.06	57.32	61.20	48.54
Shrubs:								
Golden aspen (*Populus tremuloides aurea*)	1.38	2.18	1.48	5.35	4.31	3.08	1.74	4.23
Mountain snowberry (*Symphoricarpos oreophilus*)	17.70	10.37	11.59	34.10	19.57	25.17	12.58	26.26
Other browse	8.08	4.84	2.74	5.79	6.88	2.25	4.85	4.92
Total	27.16	17.39	15.81	45.24	30.76	30.50	19.17	35.41

[1] Available forage is based on a combination of density × proper-use factor × surface acres.

The usable range varied each year because of changes in herders and in management practices. Some range subtypes were used one year and not the next; others were only partly used one year and fully used the next.

The composition of the total available forage (based on density × proper-use factor × surface acres) likewise varied from year to year, depending on the manner in which the allotments were used (table 2). However, it was apparent that within a year the same forage species were present on both allotments in somewhat similar proportions. Sneezeweed constituted a smaller percent of the available forage on allotment 2, where it occurred in small dense patches along streams or on local "key" areas, such as open parks, old bed grounds, and

around watering places. Concentrated infestations of the same kind existed on allotment 1, but there were also several larger areas supporting more or less continuous stands of the species.

Despite these differences, the areas and conditions were probably about as similar as could possibly be selected and maintained on typical mountain range and within the physical limitations of this study. In any event, sufficient similarity prevailed to permit a safe analysis of sheep management on a comparative basis between different allotments during the same year and on the same allotment during different years.

The volume of forage produced and its composition were naturally influenced by climatic conditions during the different years of study. In 1939, growing conditions were less favorable than in 1940, which was considered as an average year by those familiar with the area. The third year of the study, 1941, was better than average, and observations indicated that a greater volume of forage was produced than during the previous two years of study. The average density of the vegetation during different years, however, varied only 2.17 percent on allotment 1 and 0.79 percent on allotment 2.

Forage Utilization

To obtain local data on proper utilization, sample units of the vegetation were clipped and weighed before grazing and again after grazing (*3*). On a representative location samples of vegetation were collected at regular intervals along a traverse line. In the case of sneezeweed, for example, this consisted of clipping and weighing 10 rosettes (plant units) at each of 20 intervals along the traverse line before grazing. After the sheep had grazed the area (usually a maximum of only 3 or 4 days elapsed between before-grazing and after-grazing sampling) plant units were again clipped at definite intervals, regardless of whether grazed or not. Because grazing caused considerable variation in weight of units, more observations were required after grazing to obtain the same accuracy of sampling as before; i.e., 10 sneezeweed rosettes were clipped and weighed at each of 36 intervals. The combination of these clippings constituted a sample. The average difference in weight of the samples before and after grazing was regarded as the amount grazed, and converted to utilization percent.

Handling of Sheep

When this study was organized and started, it was recognized immediately that there was some difference in the methods of handling the two bands of sheep involved. During its first year this difference became more and more apparent until the handling of one band was classified according to generally accepted standards as poor and the other as fair. In the second year of study, circumstances developed which resulted in a complete change of management practices; by comparison, the band managed poorly in 1939 was fairly well managed in 1940, and the band that was fairly well managed in 1939 was poorly managed in 1940. In the third year of the study (1941) the method of handling both bands improved so that each could be classified as following good management practices as compared to the previous two years.

In characterizing the management employed in handling both bands as poor, fair, and good, all accepted management practices

were considered. The movement of sheep; location and use of bed grounds; herding practices in relation to watering, salting, "shading-up" use of areas infested with poisonous plants; and other similar factors were observed and considered. Owing to the wide variety of circumstances and conditions encountered, it was impossible to attempt a quantitative classification based on any of the above or any other herding practices or characteristics. Classification, therefore, was based on all accepted elements of sheep management, but in the final analysis was designated by the judgment of the observers conducting the study. The basis for the classification is shown briefly in detail in table 3.

TABLE 3.—*Detail of handling of sheep on allotments 1 and 2, 1939–41*

Year and management practice	Band 1	Band 2
1939:		
General practice	POOR	FAIR.
Attitude of herder, camp mover, and owner.	Owner provided no horse or tepee; camp moved too seldom, necessitating herder's prolonged absence at noon and a round-up on his return; camp badly located.	Good cooperation by owner and camp mover with herder. Fair herder. Camp mover stays as helper.
Routes of travel	Concentrated excessively on certain areas, as around bed grounds; with little guidance, sheep overgrazed and trampled stream bottoms and other easily reached areas—slopes and places away from water ungrazed; much trailing.	Routes quite uniformly distributed; no notable concentrations; some areas underused.
Methods of herding	In compact group, with dogs; no attempt at uniform use of range; some areas badly trampled; several times sheep left bed grounds at night to feed.	Open herding throughout season.
Use of bed grounds	Bedded usually near main camp, which was moved every 2 weeks (5 camps in all); some grounds used 7 consecutive nights; old bed grounds (sneezeweed infested) often used; late starts wasted nearly 2 hours a day grazing time.	Sheep bedded at main camp but camp moved every 2 to 4 days; 65 percent of grounds used 3 to 4 nights; old grounds generally used.
Use of sneezeweed-infested areas.	No effort to avoid infested spots or use lightly in bedding, shading-up, or grazing; many used more than once.	Sheep-shaded-up or grazed often in heavily infested areas.
Season of use	June 22–Sept. 2	June 6–Sept. 11.[1]
Culling practices	No culling; many ewes in poor condition; 93.5 percent lamb crop.	Same as No. 1, with 93.3 percent lamb crop.
1940:		
General practice	FAIR	POOR.
Attitude of herder, camp mover, and owner.	More cooperation by owner than in 1939; horse and tepee furnished.	Good cooperation by owner and camp mover, but lazy herder; used dogs at all times; sheep nervous and frightened; no effort to avoid sore spots on range.
Routes of travel	Better distribution of routes than in 1939, especially in first half of season—with more bed grounds; later, lax management led to much concentration along easily traveled routes.	Much concentration; much less uniformity of range use; tendency to travel excessively in certain areas.
Methods of herding	Great improvement in first half of year; dogs used less; sheep allowed to spread out—but reversion to 1939 practices in latter half of year.	Close herding—sheep confined to open, accessible, easily watched areas.[2]
Use of bed grounds	More 1-night grounds used, but often too close; no effort to use noninfested grounds.	Same bedding system as in 1939; about half grounds used 3 to 4 nights; old grounds used.
Use of sneezeweed-infested areas.	Some effort to avoid infested locations or use lightly in first half; no effort later.	No improvement; heavily infested areas used constantly.
Season of use	June 15–Sept. 4	June 26–Sept. 5.
Culling practices	No culling; a number of poor ewes; 105.4 percent lamb crop.	Same as No. 1, with 92.6 percent lamb crop.
1941:		
General practice	GOOD	GOOD.
Attitude of herder, camp mover, and owner.	Effort by all 3 to direct sheep according to improved practices.	Good cooperation by owner and camp mover and responsive herder, all working to avoid sneezeweed concentrations.

[1] Heavy losses this year attributable in part to too-early start; half of losses in June.
[2] Band 2 in this year had its heaviest losses from poisoning during the study.

TABLE 3.—*Detail of handling of sheep on allotments 1 and 2, 1939–41*—Continued

Year and management practice	Band 1	Band 2
1941—Continued.		
Routes of travel	Distribution much improved; more uniform utilization of forage.	Routes quite uniformly distributed; no notable concentrations.
Methods of herding	Open herding throughout season; almost no use of dogs; sheep kept from shading up in bottoms, around water holes, or on other sore spots.	Open herding throughout season.
Use of bed grounds	More than 70 percent of grounds used 1 night only; old grounds and infested locations avoided.	Grounds much better located than in previous years; more than half were used only 2 nights.
Use of sneezeweed-infested areas.	Continuous effort to avoid infested places, only a few used for shading-up or bedding; but some return in fall to spring-grazed areas.	Careful avoidance of sneezeweed concentrations.
Season of use	June 21–August 27	July 1–August 30.
Culling practices	Considerable culling; relatively few poisoned ewes; 109.5 percent lamb crop.	Intensive culling; practically all ewes in good condition; 115.5-percent lamb crop.

Observations of the study bands were made daily during the three summer grazing seasons. Detailed records of the daily routes of travel were obtained from the time the bands left the bed grounds in the morning till they reached the bed grounds at night and included such details as disposition of sheep and methods used in handling bands throughout various periods of the day, number of nights spent on each bed ground, a description of each bed ground, a daily record of all sick animals, symptoms of poisoning, death losses, and when possible the causes of death. A record of average weights and the gross income from the sale of lambs was obtained from the owners after the animals were marketed each fall.

RESULTS OF DIFFERENCES IN MANAGEMENT

General Differences

The differences in management between years for the same band and within years for the two bands were reflected in a number of effects, among which the degree of utilization of sneezeweed, death losses from sneezeweed poisoning, weight of lambs, and income from sale of lambs were subject to evaluation. Data on the relation of management to these effects are presented in table 4, and figs. 8, 9, and 10.

TABLE 4.—*Influence of range management practices as indicated by average utilization of sneezeweed, death losses from poisoning, weight of lambs, and gross income from sale of lambs* [1]

Band and year	General practice	Utilization (by weight)	Death losses	Lamb weight	Gross income from lambs	
					Total	Per ewe
Band 1:		*Percent*	*Number*	*Pounds*	*Dollars*	*Dollars*
1939	Poor	74	63	66.8	4,914	5.04
1940	Fair	59	38	67.1	5,877	6.02
1941	Good	28	11	76.5	7,331	7.51
Band 2:						
1939	Fair	45	33	75.0	5,314	5.44
1940	Poor	68	36	67.5	5,099	5.22
1941	Good	35	6	75.2	7,195	7.37

[1] For comparative purposes death losses and income have been based on an equal number of ewes entering the study allotments at the beginning of each grazing season, and on an equal sales price received for each class of lambs produced; i. e., fat lambs, feeder lambs, etc., throughout the years of study.

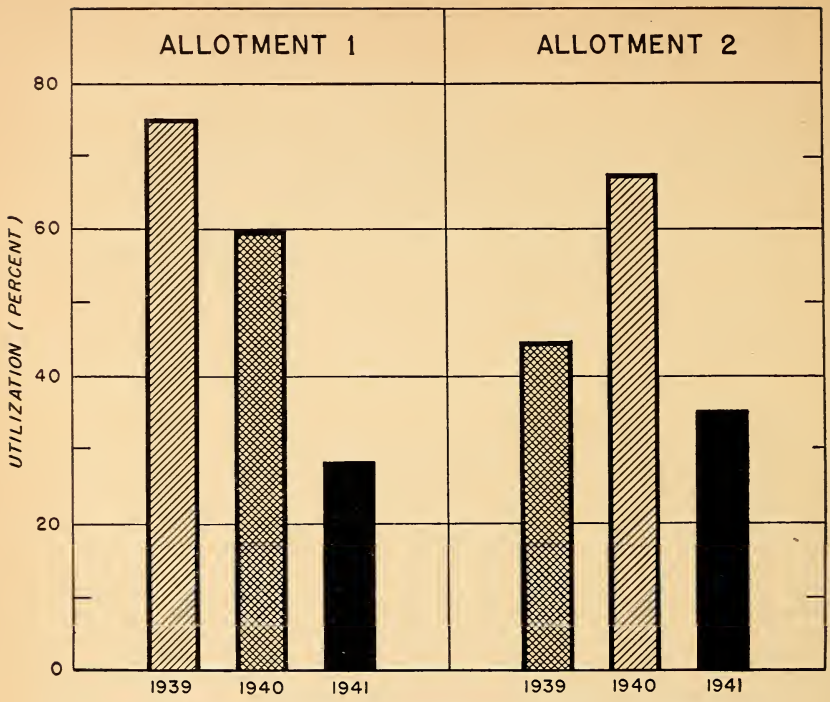

FIGURE 8.—Average utilization of sneezeweed rosettes (basal leaves).

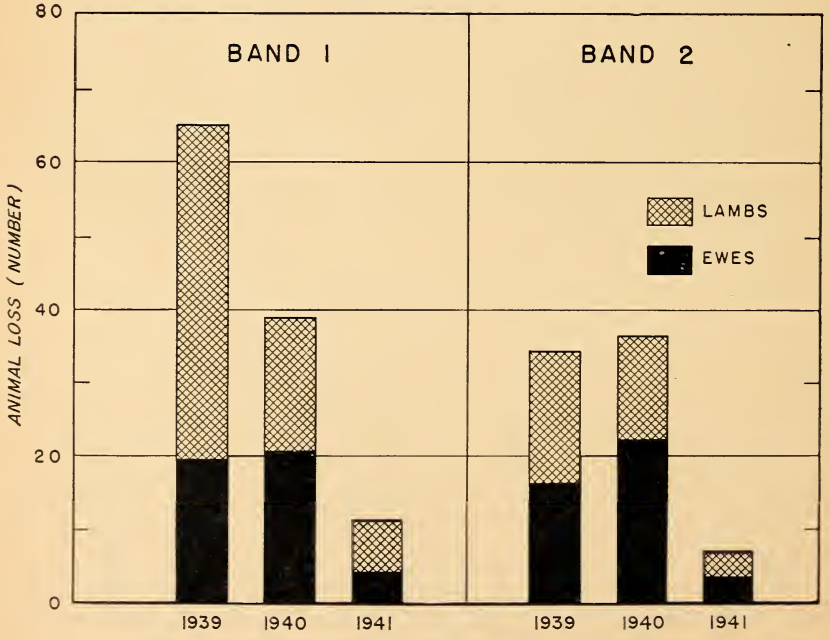

FIGURE 9.—Death losses from sneezeweed poisoning.

Band 1 (*Allotment 1*).—Improved management in band 1 during the course of the study resulted in a reduction of the average utilization of sneezeweed on the entire allotment. During 1941 this reduction (measured by weight) amounted to 62 percent of the utilization in 1939. The result was a corresponding decrease in death losses of 52 animals, or 82.5 percent. In the same time the average weight of lambs when marketed increased nearly 10 pounds on each lamb produced and added $2,417 to the gross income received from the sale of

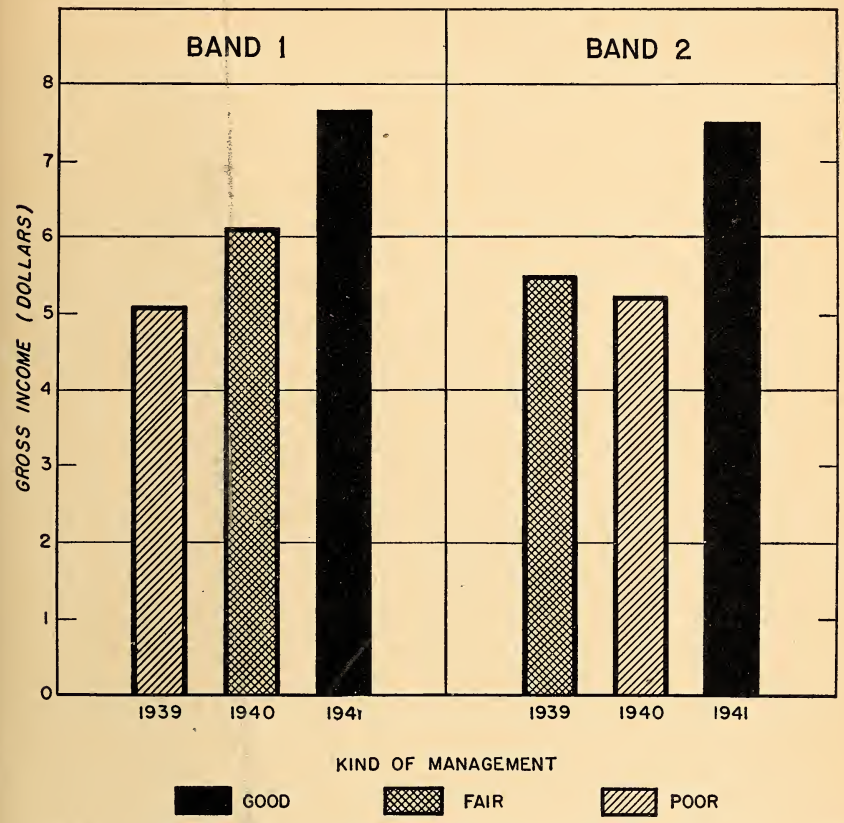

FIGURE 10.—Gross income per ewe from sale of lambs (based on common price throughout all years of study).

lambs (based on a common sale price of lambs for all years of study), or $2.47 per ewe—a 49 percent increase. Fair management of this band in 1940 yielded intermediate results in death losses, but in other respects results were rather on the "poor" side.

Band 2 (*Allotment 2*).—Although death losses from sneezeweed poisoning were at no time as severe in band 2 as in band 1, they followed the same general trend. Good management in 1941 reduced the average sneezeweed utilization to 35 percent compared to 68 percent utilization during 1940, the year of poorest management for this band. In this year death losses dropped to only 17 percent of the losses in 1940. Although weight of lambs made a less striking recovery, the

gain in gross income from sale of lambs increased $2,096 for the band and $2.15 in income per ewe. Under fair management in 1939, except for a high weight per lamb, the results were in general poor rather than intermediate.

Both bands.—A comparison of the results of differences in management of the two bands within a given year indicates the same general trend as comparisons for a given band between years (table 4). Irrespective of band or year, sneezeweed utilization and death losses decreased as management improved, and lamb weights and income improved. The fact that this trend is related to management regardless of year or band demonstrates conclusively that the climate and other external factors were not responsible for the results observed.

As between the poorest and the best years for each band, band 1 dropped 46 percent of total weight in sneezeweed utilization and band 2 33 percent. Both bands gained 83 percent over their worst score of death losses. In weight of lambs, band 1 gained 15 percent; band 2, 11 percent. The dollar gain in lambs—both total and per ewe—was 49 percent for band 1 and 41 percent for band 2. The primary reason for the greatly improved management in 1941 was that the owners of both bands were informed of the contrasting results of 1939 and 1940; as a result, they made strong efforts to improve past practices.

Losses Not Caused by Sneezeweed.—Although the study was confined primarily to losses caused by sneezeweed poisoning, a complete description of the effects of range management is not possible without including brief mention of losses associated with other factors. In this connection, loss by straying is of particular importance.

In band 1, in 1939, under poor management, 2.8 percent of the ewes and 3.4 percent of the lambs were lost by straying. In 1940, under fair management, only 0.9 percent of the ewes and 2.9 percent of the lambs were lost by straying. Under good management in 1941 no ewes or lambs were lost.

In band 2, in 1939, under fair management, no ewes were lost due to straying and only 0.6 percent of the lambs. In 1940, under poor management, 1.5 percent of the ewes and 3.9 percent of the lambs were lost by straying. Under good management in 1941, although no ewes were lost, 4.0 percent of the lambs were lost. This large loss, however, was not a reflection of management; nearly all of the lambs were lost during 1 day, August 19, in which the band was frightened by a bear and split into eight or more small groups. Because of dense timber, the herder experienced great difficulty in gathering the band and approximately 40 lambs were never found.

Death losses from miscellaneous causes, such as predators, blue bag, pneumonia, etc., are influenced by management to some extent, but, inasmuch as numerous other factors also influence the loss from these causes, no direct correlation with management was attempted in this study.

Components of management.—The most important practices in sheep handling have been listed in table 3, namely: (1) Attitude of herders, camp movers, and owners; (2) distribution of routes of travel, influencing the uniformity of range use; (3) methods of herding; (4) use of bed grounds, including distribution, location, and degree of use; (5) use of sneezeweed-infested areas; (6) season of use; and (7) culling practices. Each of these aspects of management had its part in the unfavorable results of poor management and the striking

improvements realized under good management. Consequently, it is well to consider them separately.

Attitude of Herder, Camp Mover, and Owner

To obtain effective range use it is essential that proper management be planned in advance of the grazing season by the manager or owner. The herder must understand what is expected of him, and the manager must provide all the facilities and cooperation necessary to carry out the plan. Instances were noted in each band wherein the negligence or lack of cooperation of the men handling the sheep resulted in poor management and increased losses.

This is especially true of the men handling band 1 in 1939. The owner's failure to provide a horse or tepee for the herder was responsible for the latter's inefficiency both in bedding out and herding during that first year. The camp mover did not move camp as often as the herder desired, or place it in the most suitable areas. The almost daily necessity for a round-up when the herder returned from the main camp after lunch resulted in loss of feeding time, undue trampling of the range, excited and nervous animals, and hence increased utilization of sneezeweed.

As a result of the better cooperation in good management, evident among the men in 1940, and still greater cooperation in 1941, when all worked together in an effort to direct the sheep in accordance with the proven practices, the various herding and bed-ground practices changed for the better in these years, and losses declined correspondingly (table 4).

The great importance of the cooperation of the herder with owner and camp mover was illustrated by the management of band 2. Throughout the study the owner and camp mover cooperated with the herder in providing equipment, moving the camp frequently, and in preparing meals and searching for stray sheep, but this availed little with the lazy herder employed in 1940. His indolence and negligence, as evidenced in his spending considerable time in camp, using dogs incessantly in herding, and making no attempt to avoid "sore" spots on the range, resulted in nervous and frightened sheep and a range badly trampled and never uniformly used. These malpractices in the handling of the sheep in this year resulted in more sneezeweed being utilized by this band than at any other time, and the highest death losses naturally followed (table 4). The utilization of sneezeweed in 1941, which was about half that of 1940, and the very low loss of only 6 animals, as compared to 36 in the previous year, were due in no small part to the good cooperation of the herder combined with that of the camp mover in avoiding sneezeweed concentrations in locating bed grounds.

Daily Routes of Travel

During the grazing season the routes of travel of both study bands were observed and plotted.[8] The direction and distance traveled by the bands were recorded at hourly intervals throughout each day, and the disposition of the sheep and herding practices in use were described. From these data comparisons of the results of travel between

[8] Base maps from an aerial survey showing range subtypes, drainages, etc., were available for each study allotment. The main topographic and cultural features were flagged at regular intervals, numbered, and located by number on the base maps. By use of these orientation points the observers were able to plot accurately the routes of daily travel.

bands and between years were easily drawn. The distribution of travel or routes of movement on a typical area in each allotment is shown for each of the three years of study in figure 11.

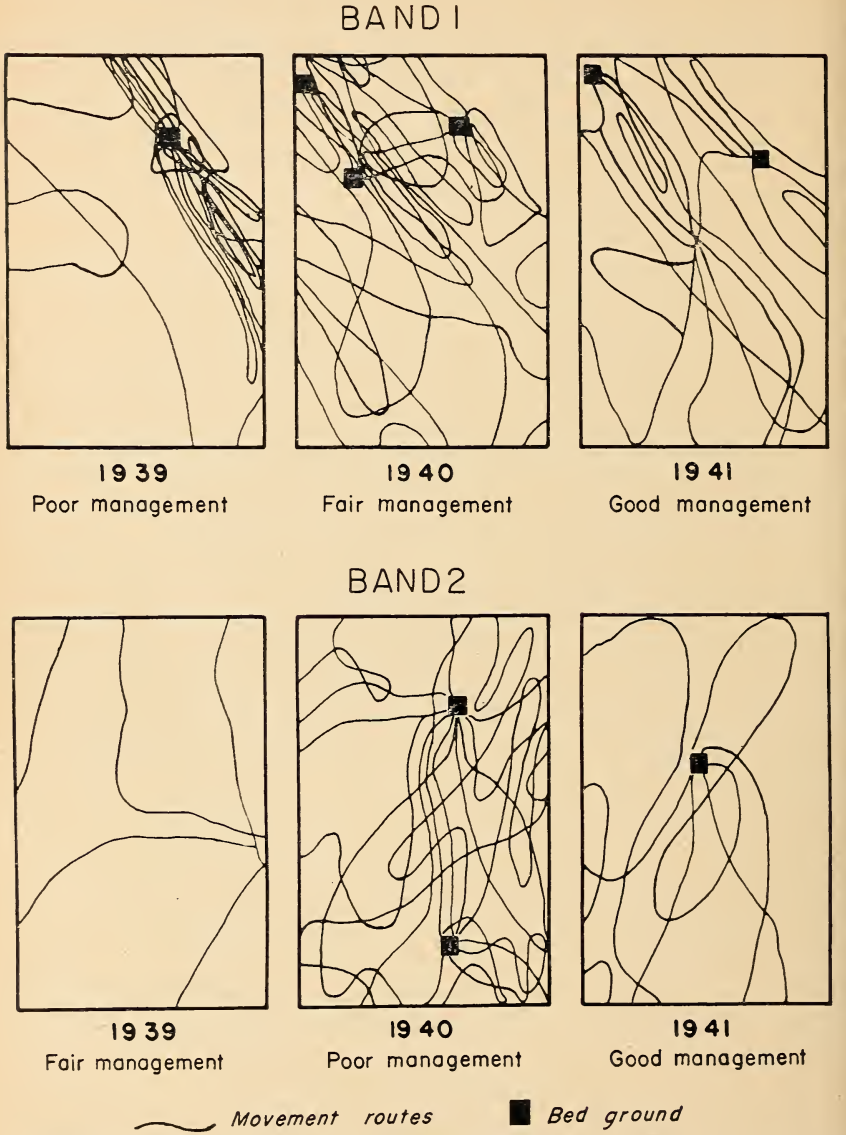

FIGURE 11.—Daily movement routes of bands 1 and 2 on the same areas during different years. Squares indicate bed grounds.

The travel of band 1 during 1939, a year of poor management, when the sheep were allowed to follow the paths of least resistance, contributed definitely to the heavy use of sneezeweed in that year (fig. 12). In the year that followed, the use of additional bed grounds and some

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FIGURE 12.—Deep trails along steep drainages indicate the high degree of trailing and local concentration on allotment 1 in 1939. This practice resulted in heavy utilization of sneezeweed and excessive losses from poisoning.

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FIGURE 13.—The trampled grass tufts and browse plants denuded of leaves illustrate the extreme degree of use when band 1 was allowed to concentrate on portions of the allotment during the latter part of the 1940 grazing season.

attempt to plan the movement of sheep resulted in a more uniform coverage of the range. Later in the season, however, concentration of sheep became common (fig. 13). By 1941, when the movement was improved to the point where rather uniform, well-distributed use was obtained, sneezeweed utilization diminished greatly, frequently to less than one-third to one-half of the use when concentrated travel was employed. This is clearly shown in table 5, the data for which were collected at the same location for each year during which the routes of travel varied. Other elements of management also influenced the utilization of sneezeweed, but for the areas compared in table 5 travel was undoubtedly the dominant factor in determining the variation observed.

TABLE 5.—*Utilization of sneezeweed by the 2 bands at the same location on each allotment for different years*

Location	Allotment 1			Allotment 2		
	Concentrated travel (1939)	Uniform travel (1941)	Difference in utilization when travel improved	Concentrated travel (1940)	Uniform travel (1941)	Difference in utilization when travel improved
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
A	59	28	31	62	15	47
B	82	30	52	86	25	61
C	80	31	49	87	2	85
D	85	0	85	56	40	16
E	70	38	32	48	31	17
F	76	38	38	76	27	49
G	85	21	64	36	0	36

Owing partially to the greater size of band 2, its routes of travel were less concentrated during each year of study than were those of band 1, as shown in figure 11. The results on sneezeweed utilization of the variation in travel practiced by band 2 have the identical trend as those observed for band 1 (table 5). Where sheep pass over an area too frequently, sneezeweed utilization increases accordingly. This increased utilization results, of course, in increased losses.

METHODS OF HERDING

For many years the advantages of open, quiet herding have been recognized (7), but this principle is more important than ever on ranges infested with sneezeweed. The practice of open herding, or allowing the sheep to spread out uniformly over the range, permits the animals to be selective in their choice of forage. If the band is herded in a compact mass, the leaders utilize the most desirable forage, leaving the inferior species for the laggards who have no choice but to follow closely one behind the other. Quite often a number of the laggards at the rear of the band are the weaker individuals, already in poor condition from the effects of sneezeweed poisoning; when they are forced to graze additional sneezeweed, their condition declines and death results.

The excessive and injudicious use of dogs in herding excites the sheep, makes them nervous, and causes them to congregate quickly at the slightest disturbance. On sneezeweed-infested areas the excessive

use of dogs is particularly serious, since the chances of poisoning are increased when normal grazing habits are upset. If a horse is used in herding, the frequent use of dogs can be largely avoided, thereby aiding in accomplishing quiet herding.

Although it is impossible to isolate the effects of herding on sneezeweed utilization and poisoning, there is no doubt that undesirable practices had a great influence on losses sustained. As the herding system of band 1 improved over the 3 years of study (table 3), losses from sneezeweed poisoning declined (table 4).

On the other hand, the laziness and inefficiency of the herder of band 2 in 1940 (table 3) was the major factor contributing to the poor management slump of this band, and directly caused a loss of approximately $2,000 in income from the sale of lambs.

Use of Bed Grounds

The proper use of bed grounds on summer ranges has been advocated and quite generally enforced on national forests. The rule has been that a single area should be used as a bed ground no longer than one night, if possible, and never more than three nights. Consistent violation of this rule may cause damage to the range so serious that years of adjustment will be required to correct it.

In the present study the importance of use and location of bed grounds was especially recognized and careful study was made of this element of management. Poor bed-ground practice was found invariably to be associated with excessive use of sneezeweed.

In 1939 the lack of a horse or tepee prevented any "bedding out" of band 1. The lack of wisdom in locating camps resulted in repeated use of old bed grounds, depleted in previous years and supporting stands of sneezeweed, and consequently heavy utilization of sneezeweed (fig. 14, *A*, *B*). The various poor practices employed for band 1 in 1939 resulted in the range on and near bed grounds being damaged seriously by heavy use; in a surplus amount of travel time to and from bed grounds which could have been used for feeding; and in the increase of utilization of sneezeweed on and near areas of concentration over and above the point where poisoning occurs. Obviously these results contributed to the high loss from sneezeweed poisoning and relatively low income from lambs in that year, as presented in table 4.

In 1940, although there was a decided improvement (fig. 15), the practices for this band were still far from satisfactory and heavy utilization of sneezeweed on and near bed grounds was frequent.

Because no effort was made in either of the first two years of study to select noninfested areas for bed grounds, any unwise use tended to cause heavy sneezeweed utilization. It should be understood that the terrain, timber, and vegetation were such that locating suitable bed grounds was somewhat difficult, requiring considerable effort, skill, advance planning, and cooperation between herder and manager.

In 1941, with the greatly improved use of bed grounds by band 1 and other improved practices, the average utilization of sneezeweed over the entire allotment decreased to one-third of that in 1939 and one-half as much as in 1940. There was a corresponding decrease in losses from poisoning, the number of deaths dropping from a

maximum of 63 in 1939 to a minimum of 11 in 1941. In the same period average lamb weights increased from 66.8 to 76.5 pounds.

A different system of general management affecting the use of bed grounds was employed for band 2, whereby the camp mover stayed

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FIGURE 14.—Bed grounds used for many nights may be denuded of vegetation, and years of nonuse are necessary for recovery. *A*, Bed ground used by band 1 for seven consecutive nights in 1939, in spite of even longer use in previous years. Nearly 10 acres around the bed ground is practically denuded of vegetation. *B*, Bed ground on an adjacent allotment which was used excessively, similarly to *A* (above) until 1930. Ten years of nonuse has permitted the area to recover.

with the band and helped prepare meals, searched for stray sheep, and performed other miscellaneous duties. The sheep were bedded at the main camp each night; but the camp was moved every 2 to 4 days. The main camp in this instance is really the only camp and

represents a condition intermediate between a fixed camp location and the tepee system.

In 1939 and 1940 too many bed grounds were used by band 2 for three or more nights. The decided improvement in the location of bed grounds in 1941 (accompanied, however, by no great improvement in the number of consecutive nights the bed grounds were used) did not, in general, influence greatly the variation in losses from sneezeweed poisoning. Although the adjustments in practice were for the better, the opportunities for improvement were never as great as for band 1. The reduction in number of nights' use of individual bed grounds in 1941 probably contributed, however, to the reduction

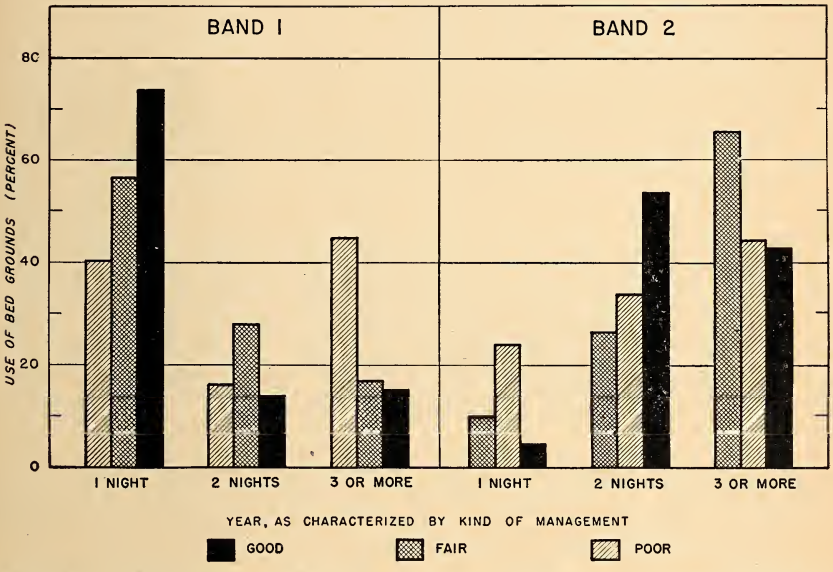

FIGURE 15.—Use of bed grounds by both bands in the three successive (1939–41) years of study.

of losses to a minimum of six animals, and the maximum average lamb weight during this year of study of 75.2 pounds.

The Use of Sneezeweed-Infested Areas

Obviously no poisonous plant would be a problem on the range if the area where it grows could be avoided. In some cases, however, it is not possible to avoid these areas and in other cases the poisonous plants may be so widespread that any effort toward complete avoidance would result in uneconomic use of the range. On sneezeweed-infested range, a combination of practices appears desirable; namely, complete avoidance of localized dense stands of plants and light use of the widespread sparser stands.

In the present study, as shown in table 3, the practice of moving the sheep in reference to sneezeweed infestations varied from year to year and between bands with marked results in death losses.

Throughout the grazing season of 1939, and during the latter part of the 1940 season many of the sneezeweed-infested areas were grazed

more than once by band 1. Naturally the first time an area was grazed, although some sneezeweed might be utilized, the more desirable forage plants had the principal use. As the area was grazed again, sneezeweed utilization increased greatly, because less of the more palatable associated vegetation was available. This is illustrated by data collected from several areas before and after grazing a second time and presented in table 6. These data show that in extreme cases grazing over an area a second time may increase sneezeweed utilization from practically nothing to more than 40 percent.

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FIGURE 16.—Heavy sneezeweed utilization. Band 2 used this area as a bed ground for two consecutive nights, and "shaded up" nearby during 1 day. Extremely heavy utilization results from allowing the sheep to concentrate on areas supporting the poisonous plant. The coarse stalks are all that remain of a luxuriant growth of sneezeweed.

Even where utilization may have been rather high after the first grazing (for example, 43 percent), it was practically doubled by a second grazing.

TABLE 6.—*Sneezeweed utilization determined at the same location after grazing once and twice*

Location No.	Utilization		Location No.	Utilization	
	Grazed once	Grazed twice		Grazed once	Grazed twice
	Percent	*Percent*		*Percent*	*Percent*
1	28	70	5	43	85
2	30	68	6	48	80
3	17	85	7	29	75
4	25	85	8	0	42

The practice of returning in late summer and fall to a sneezeweed area that has been grazed earlier in the season, as occurred each year with band 1, is generally more serious than returning earlier in the season, since sneezeweed may be the only green and succulent forage available after the first autumn frost. Except for this practice, band 1 was herded over selected routes in 1941, to avoid sneeze-

weed stands or use them only lightly, and undoubtedly this effort aided much in attaining a reduction of losses.

The practice followed with band 2 in 1941 of avoiding heavy sneezeweed stands when the sheep are most hungry or when they are concentrated, was exceedingly important in reducing the losses from poisoning in that year to only six animals. The high utilization of the plant in 1939 and 1940—45 and 68 percent—indicates the effect of "shading up" in heavy stands of sneezeweed and locating bed grounds on or near sneezeweed concentrations (fig. 16).

Seasons of Use

Inasmuch as sneezeweed starts to grow in the spring before desirable forage plants and remains green in the fall after associated plants have dried, grazing must be regulated to avoid use of infested range at these times. If this is not done, heavy utilization of sneezeweed and poisoning can be expected.

The season of use by band 1 from year to year was rather uniform and consequently bears no evident relation to the variations in sneezeweed utilization and losses that occurred. The fact that band 2 entered its allotment in 1939 as early as June 6 undoubtedly contributed to the rather heavy losses in this year and probably accounts for the fact that nearly half of the deaths occurred during June. Although the total volume of forage present on the allotment was adequate throughout the year, even in 1939, the early-season grazing was highly undesirable.

Culling Practices

Ewes or lambs poisoned by sneezeweed never completely recover. Sheep poisoned on the summer range may not die immediately, and may even seem to improve during the winter. However, as soon as they are placed on green feed the following spring their condition declines steadily, and death may result with or without additional sneezeweed being grazed.

This study was not organized in such a way as to permit observation of the culling practices. Nevertheless, at the time the bands entered the allotments, the number and condition of ewes that had apparently been poisoned in the past and not culled were observed. Also the percent lamb crop at the time of entering the allotments was determined, and the size of lamb crops is reflected somewhat by the effectiveness of culling, as given in table 3.

CONTROL OF SNEEZEWEED

Although control of sneezeweed by artificial means is impractical on ranges where it is abundant and widespread, as stated in 1921 by Marsh et al. (*9*), there may be localities where some control is desirable and practical. For example, on ranges where sneezeweed is invading but is still confined to small tracts, it is highly desirable that some effective control be attempted before the plant spreads too widely. Or, where dense stands occur at strategic locations such as around water holes, some control in connection with general range administration and use may be feasible. In view of these possibilities of control, a special investigation in connection with this

study was undertaken to determine methods that would be effective in situations where it might be profitable to use them.

Several methods were tested, including grubbing with various tools, reseeding with competitive plants, and application of various chemical soil sterilants. All were tried under a wide variety of seasons and weather conditions over a 2-year period.

The results of this phase of the study indicate that control of sneezeweed is no simple problem. Chemical soil sterilants, such as borax or borax-sodium chlorate mixtures, are difficult to apply in quantities which will kill the sneezeweed without damaging associated desirable plant species. Reseeding did not seem to be providing sufficient competition during the course of the study to have any effect on the sneezeweed stand. Grubbing, however, was effective in reducing the sneezeweed stand and with an effective "follow-up" the second year can attain almost complete control.

The easiest, most effective grubbing was done with a weeding tool, somewhat similar to a potato rake, with a rake on one side for pulling the plants and a cutting edge on the other for digging. Grubbing with this tool not only controlled the sneezeweed but did little harm to the associated plants. Grubbing at any season was effective but in every case a follow-up treatment a year after the primary treatment was essential.

It is estimated that grubbing the average stand of sneezeweed would cost about $15 an acre, which is prohibitive, of course, except where control of a very small area would protect a very much larger one. Rather frequently, however, herders and camp movers in spare time can control small infestations on old bed grounds, along stream bottoms or elsewhere and thereby reduce the hazard at little direct cost. Such a practice is highly recommended wherever it is considered practical by the range user. It is well, in this connection, to emphasize the previous statement, that where sneezeweed is in process of invading an area considerable expenditure may be justified to remove the threat of a more widespread infestation in the future.

RECOMMENDATIONS

Results of this study indicate that sneezeweed-infested ranges can be used effectively for sheep production if certain management practices are followed. These practices are simple but must be observed rigidly if sneezeweed utilization and consequent death losses are to be held to a minimum. The following recommendations, although made primarily for infested range, include a number that have been or should be used on noninfested ranges throughout the West.

Graze Sneezeweed-Infested Areas Lightly.—The key to proper use of sneezeweed ranges is to keep the daily use of sneezeweed below the amount which will be poisonous. Since sneezeweed infestations often occur in scattered patches of a few acres, such areas can usually be avoided when the sheep are concentrated or are most hungry. Dense stands of the plant should never be grazed. Range supporting very moderate to light stands of sneezeweed should never be grazed a second time in the same season since sneezeweed utilization increases greatly when other desirable forage has been eaten. Owners or administrators of heavily infested range lands should make ample

allowance to permit very light or nonuse of infested areas. To accomplish this, reduction in the number of stock may be necessary; or shortening of the grazing season, combined with more uniform use of other portions of the range.

Do Not Graze Sneezeweed-Infested Range in the Early Spring.—Sneezeweed begins active growth in the spring as the snow disappears and develops in advance of associated species. Sneezeweed plants are often 4 to 6 inches high when the desirable forage species are just beginning to grow. If the range is grazed under these conditions, poisoning almost certainly results.

Remove Sheep From Sneezeweed Areas as Soon as Desirable Forage Begins to Dry.—Sneezeweed begins a new growth cycle in the fall, and remains green and succulent after the first fall frost, whereas the associated vegetation dries and becomes less palatable. This fall period is the most dangerous on infested ranges, and an attempt to stay "just a few days longer" is often disastrous. Management plans should provide for deferring noninfested portions of the range for the fall period.

Practice Open, Quiet Herding.—Allow the band to spread out and graze leisurely and quietly without interference. The use of a horse aids in most instances in effective distribution. Dogs should be used as little as possible, particularly where sneezeweed is present, in order to avoid concentration of the sheep. Herders should control the advance of the leaders of the band and adjust their rate of travel to the slower individuals in the band instead of continually pushing the laggards to make them keep up with the leaders.

Use the Range Uniformly.—Direct the sheep to all portions of the range. Plan routes of travel to take advantage of available watering facilities, so the sheep do not spend needless hours trailing along streams or concentrated at springs.

Use Bed Grounds for Only One Night, Employing "Bedding-Out."—Direct the band throughout the day so that forage is available at all times, when leaving one bed ground as well as when approaching the next. The herder must remain with the sheep during the night on most summer ranges because of the danger from predators.

Select Carefully the Locations for Bed Grounds.—In locating bed grounds, plan carefully in advance in order to (1) avoid locations on or near stands of sneezeweed; (2) obtain uniform spacing of bed grounds over the allotment; (3) avoid areas damaged by previous use; (4) select fairly level areas that are covered with a good stand of vegetation so that the inevitable trampling will not cause marked disturbance of the soil and undue erosion; (5) avoid bedding near streams, springs, or other places that naturally are heavily used.

Take Full Advantage of the Daylight Hours for Grazing.—Sheep should not remain on the bed ground long after dawn or return to graze on or around the bed ground much before dark. Salt should not be distributed on the bed ground until just before dark, or the sheep may come to the bed ground too early and remain there. Sheep are less selective in their choice of forage after eating salt, and will consume large quantities of sneezeweed if it is available. Naturally the more time spent on bed grounds the more the forage is depleted; and such depleted and disturbed areas provide excellent opportunities for sneezeweed invasion.

Employ a Good Herder and Instruct, Equip, and Aid Him Properly.—The importance of securing a competent, active herder who knows sheep

and is familiar with the country and the poisonous plants that grow there cannot be overemphasized. He should be well equipped and specifically instructed. Close herding, excessive trailing, or the injudicious use of dogs should not be allowed. Point out areas to be avoided, bed ground locations to use or not to use, watering facilities, etc. Provide the herder with a tepee and horse. See that the camp mover locates the base camp conveniently so that the herder need not spend much time away from the band. The camp mover should also be instructed to avoid infested locations and old grounds. A little extra care in selecting a herder or in providing proper equipment, instructions, assistance, and supervision can easily result in the difference between profit and loss on a band of sheep.

Cull the Flock Closely.—Mark badly poisoned animals when first noticed and sell them as soon as possible. Each fall cull out all sick, poor, poisoned, or otherwise nonproductive animals. Do not keep poisoned ewe lambs for replacements.

Control Sneezeweed Where Practicable.—Where invasion has just begun or denser stands threaten the use of strategic areas, control of sneezeweed by grubbing with an adequate follow-up a year later is effective and well worth some outlay. Herders and camp movers should be instructed to carry on control incidental to their other work on small units, where their effort will be effective in protecting a much larger area, or where it will improve general use of the range.

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